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Surface Modification and Surface - Subsurface Exchange Processes on Europa

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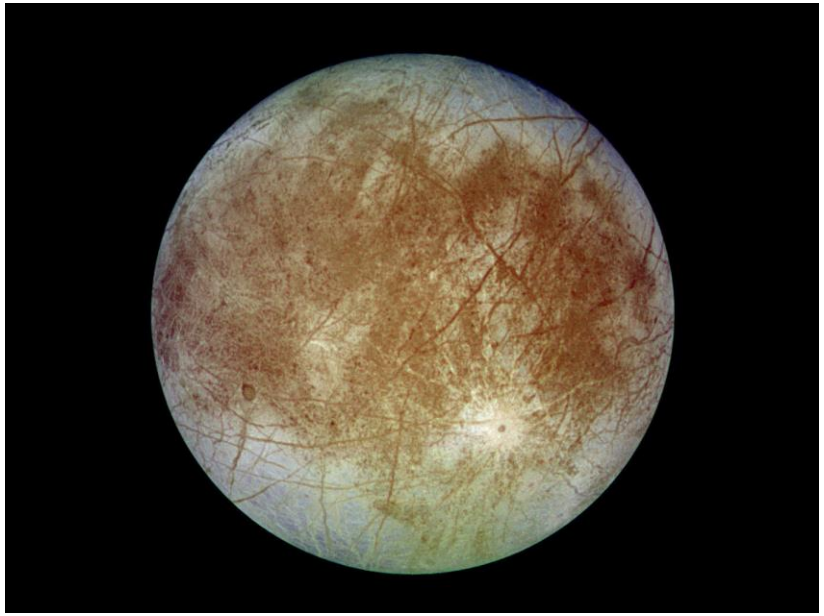
Europa's surface

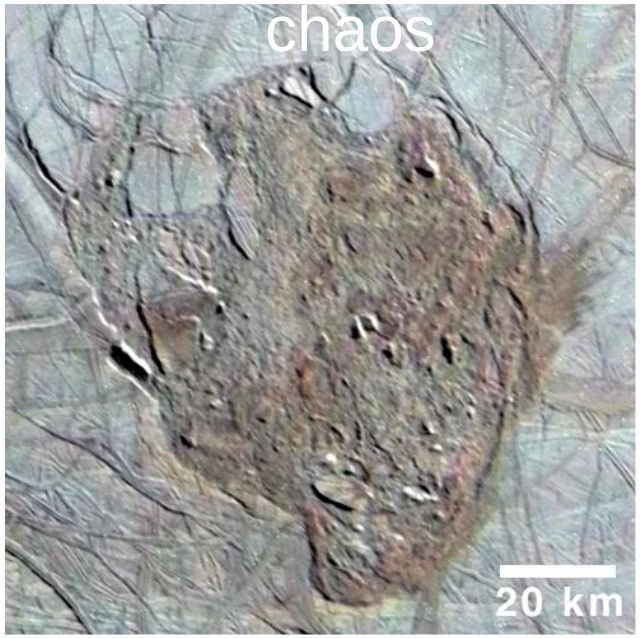
- What processes dominate the top **meter** of Europa's surface?
- How do those processes extend to surface – subsurface exchange?



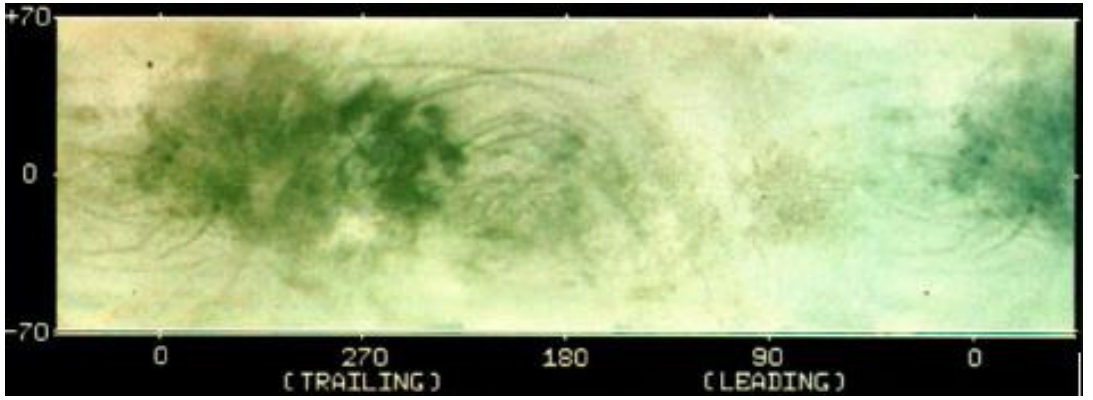
Goal:
Global estimate of surface – subsurface exchange rates and localized surface properties

Surface properties & dynamic processes

- Properties & processes vary by location on surface
- Properties include:
  - Composition, ice vs. non-ice materials
  - Porosity, strength, thermal inertia
  - Grain size, crystalline vs. amorphous
- Processes include:
  - Radiation processing
  - Sintering
  - Sputtering
  - Gardening
  - Thermal segregation / Sublimation
  - Mass wasting



Variation with location



McEwen et al. 1986

- Leading / trailing hemisphere asymmetry in brightness / color / porosity / composition
  - Due to irradiation, sulfur ion implantation (SO_2 on trailing)
  - Magnetospheric interactions vs. micrometeorite impacts
- Higher thermal inertia at mid-latitudes
  - Block abundance / roughness?
- Composition varies with geologic unit
  - Ridges / bands / chaos have more non-ice material than background plains units
- One big caveat: Remote sensing observations only sensitive to very top surface layer
  - Remote sensing layer: λ-dependent, μm to cm thick

EUROPA

CHARGED PARTICLES

SUNLIGHT

IMPACTS

PLUME MATERIALS

SURFACE

PLUME DEPOSITS

CHAOS, LINEAE EXTENSIONAL FEATURES

OVERTURNED BLOCKS

ICE FRACTURES & VEINS

DIAPIRS

ICE

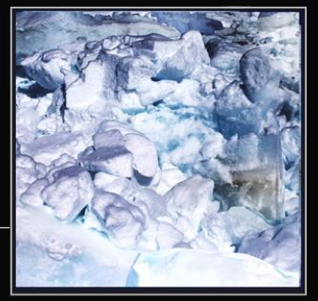
~10 km

OCEAN

OCEAN CURRENTS

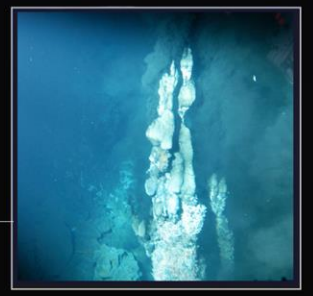
~100 km

ROCK INTERIOR

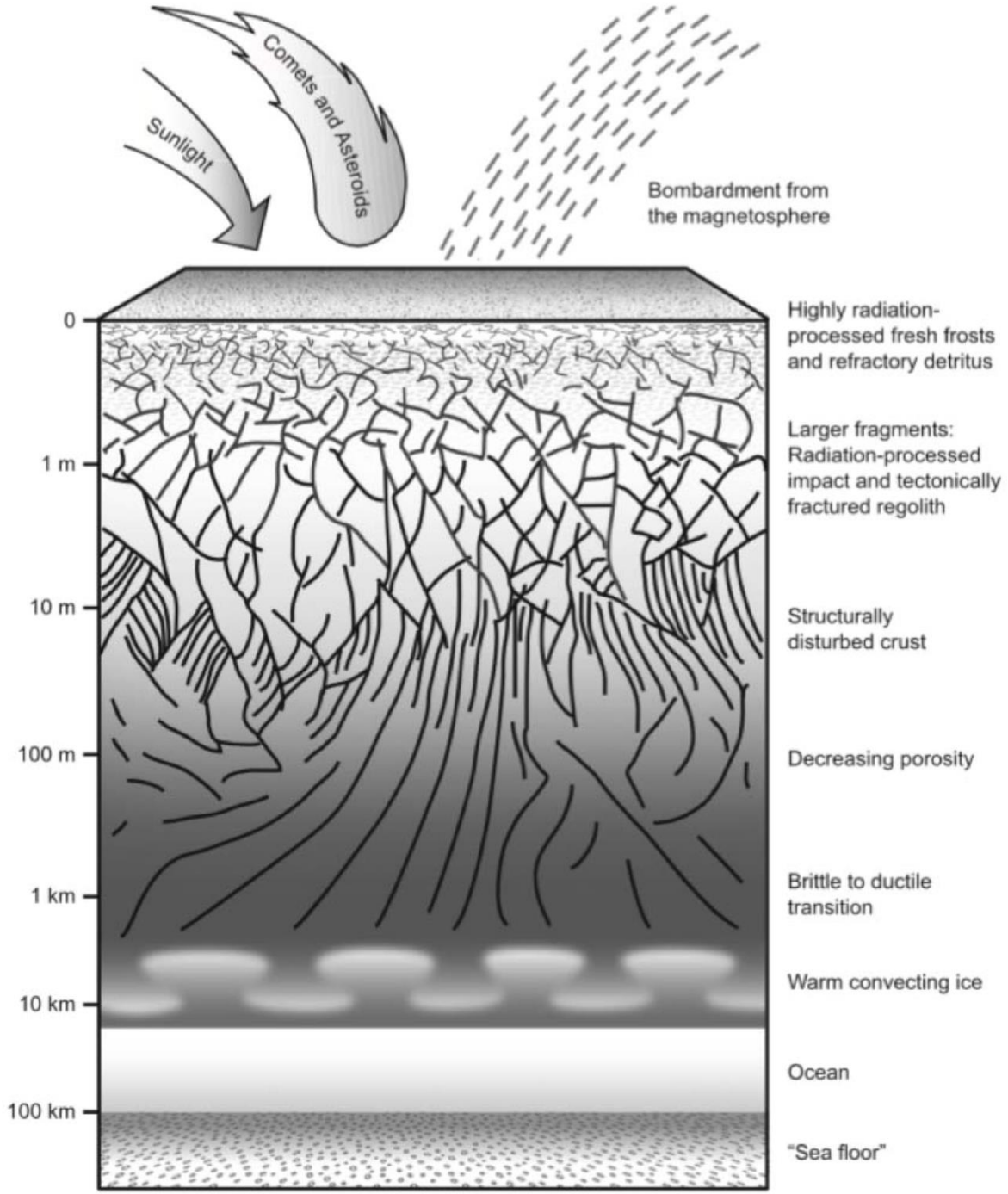


ICE BLOCKS

ICE FRACTURES

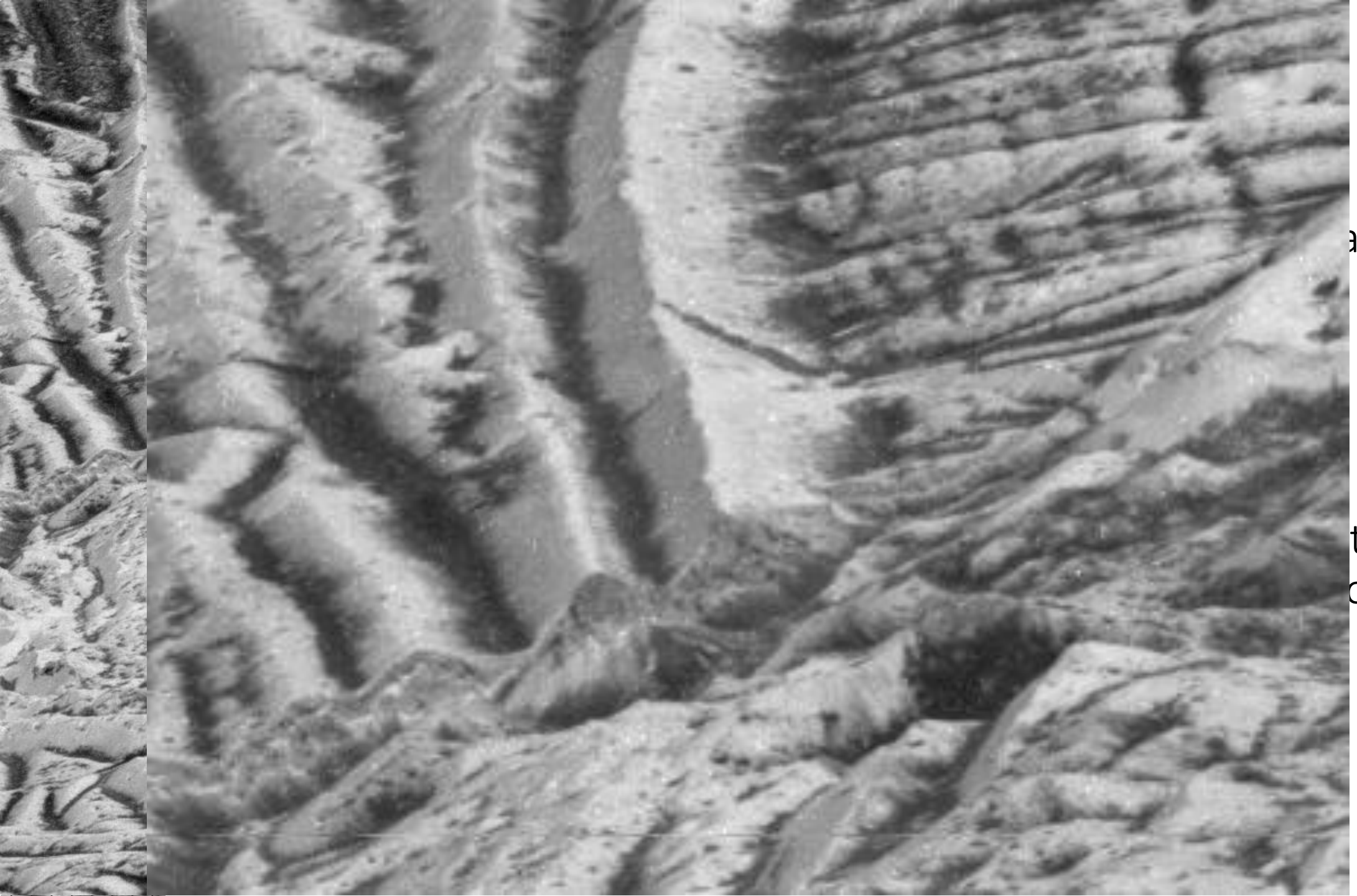


HYDROTHERMAL VENTS



- What processes dominate the top meter of Europa's surface?
- How do those processes extend into the subsurface?

From Moore et al. 2009



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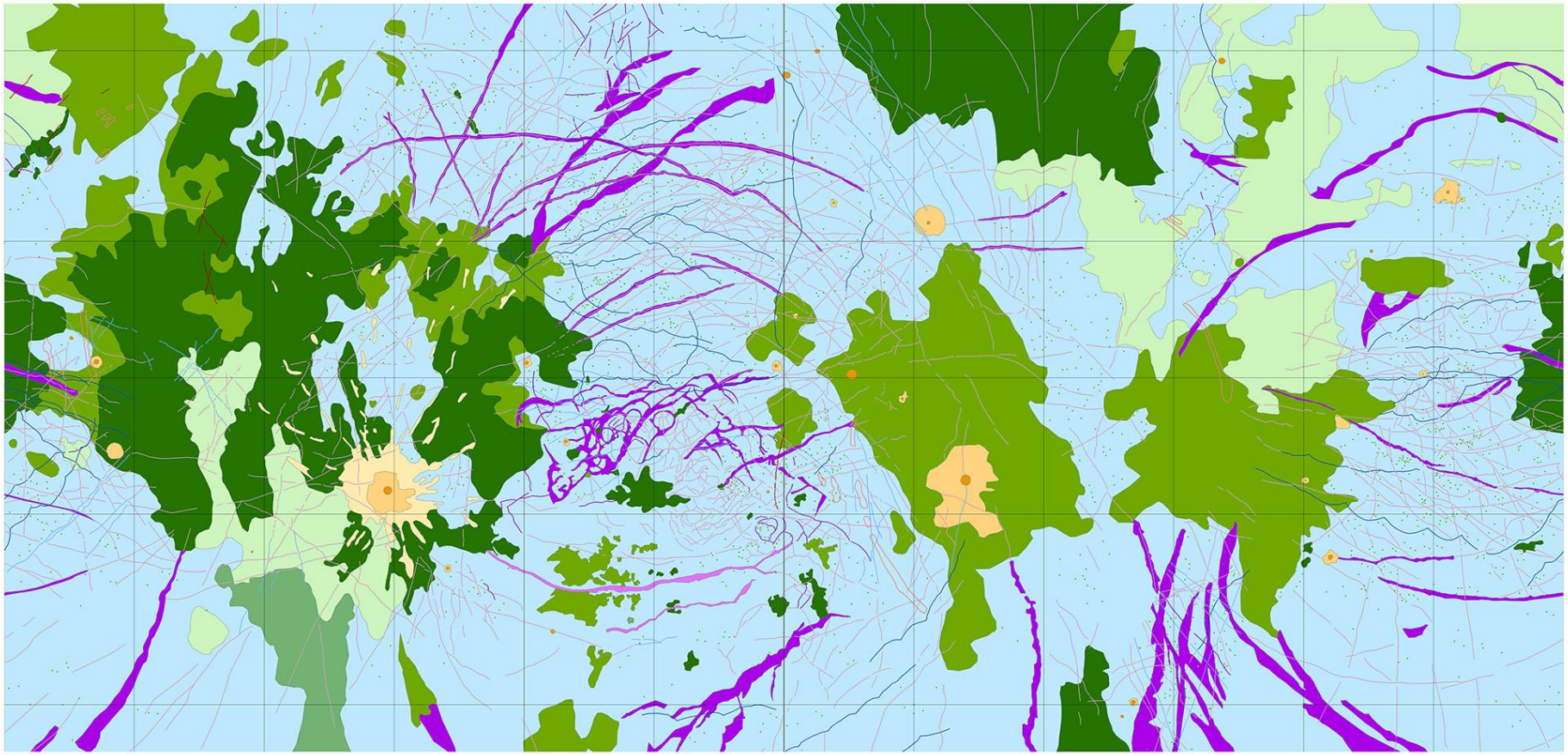
Interactions of surface modification mechanisms, and spatial distribution

- Different processes modify Europa's surface at the same time, and therefore interact with each other as well
  - I.e., thermal segregation: warm lag deposit at topographic lows, bright volatile water frost deposit at local highs.
  - Sintering rate may be higher in new frost deposits (higher vapor transport rate), but sintering rate also decreases exponentially with decreasing temperature.
  - Research into sintering rates will include study of whether vapor transport or temperature dominates in this situation (Jamie Molaro presented poster on Europa sintering yesterday, P43D-2906)
- Surface modification and surface / subsurface transport depend on geologic units and feature formation mechanisms

New Europa global geologic map!



By Erin Leonard and D. Alex Patthoff
Was presented on Wednesday: Poster P33A-2862

Surface area coverage by feature type

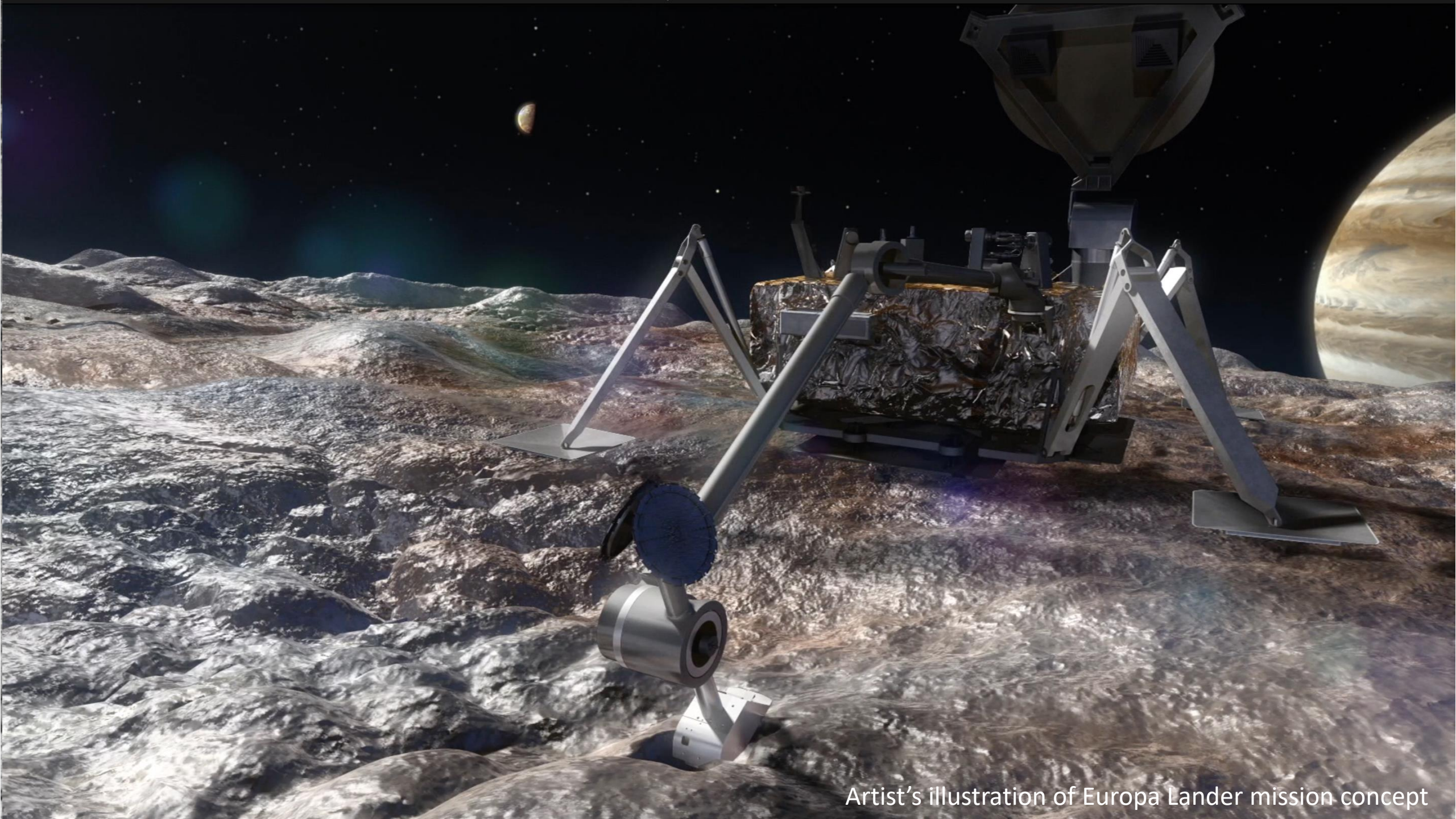
From Leonard et al. Geologic map

- Bands cover ~3.5 % of Europa's surface (includes all band types)
- Craters cover ~1.6 % of Europa's surface (includes craters plus ejecta)
- Chaos material covers ~41.6 % of Europa's surface (including microchaos)
- Ridged plains cover ~53.3 % of Europa's surface (includes primary ridge complexes as well as background ridged plains)

Implications: resurfacing and surface / subsurface exchange rates vary by feature type; chaos may dominate due to sheer abundance even if craters / ridges / bands have higher individual transport rates

Global view of surface modification, surface-subsurface exchange

- Why do we care? LANDING ON EUROPA!
- What is going on in the top meter?
- How to understand the surface
  - Combine remote sensing data we have, related rates
  - Theoretical modelling
  - Laboratory studies (under Europa surface conditions)
  - Field work at terrestrial analog environments
  - Europa surface simulants
- Ongoing, integrated work – stay tuned!



Artist’s illustration of Europa Lander mission concept